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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/863,224	05/24/2001	Ming-Hsing Tsai	TS00-563	9872

28112 7590 05/05/2003

GEORGE O. SAILE & ASSOCIATES
28 DAVIS AVENUE
POUGHKEEPSIE, NY 12603

EXAMINER

BEREZNY, NEAL

ART UNIT	PAPER NUMBER
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2823

DATE MAILED: 05/05/2003

11

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/863,224

Applicant(s)

TSAI ET AL.

Examiner

Neal Berezny

Art Unit

2823

-- The MAILING DATE of this communication appears on the cover sheet with the corresponding address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 10 February 2003.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-33 is/are pending in the application.
- 4a) Of the above claim(s) 31-33 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-30 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 24 May 2001 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

DETAILED ACTION

Claim Rejections - 35 USC § 112

1. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claims 8 and 25 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The use of "and" in the claim requires that all the listed materials appear in the low-k dielectric. The specifications appear not to teach this combination of materials, see p.19.

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in-

(1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effect under this subsection of a national application published under section 122(b) only if the international application designating the United States was published under Article 21(2)(a) of such treaty in the English language; or

(2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that a patent shall not be deemed filed in the United States for the purposes of this subsection based on the filing of an international application filed under the treaty defined in section 351(a).

4. Claims 1, 3-5, 7-10, 12-16, 18-20, 22, 25-26, 28, and 30 are rejected under 35 U.S.C. 102(e) as being anticipated by Zhou et al. (6,358,842). Zhou teaches a method to solve via poisoning for insulative porous low-k materials, see abstract, comprising the steps of:

providing a silicon substrate, col.3, ln.55-57, having a silicon nitride passivation layer with a thickness of 30-1000 Angstroms, col.4, ln.12-15, formed over a first metal layer formed on said substrate; fig.4, el.50, 58, and 54, forming a first insulative layer, with a thickness of 2000-100000 Angstroms, col.4, ln.49-52, over said substrate; el.62, forming a silicon nitride etch-stop layer, col.4, ln.60-63, with a thickness of 30-1000 Angstroms, col.4, ln.65-67, over said first insulative layer; el.66, forming a second insulative layer, with a thickness of 2000 to 100000 Angstroms, col.5, ln.34-37, over said etch-stop layer; el.70, forming a first photoresist layer over said second insulative layer and patterning said photoresist to form a first photoresist mask having a hole pattern; fig.5, el.78, etching said first and second insulative layers, including said etch-stop layer through said hole pattern to form a hole reaching said passivation layer; fig.5, removing said first photoresist mask; forming a low-k protection layer over said substrate, including in said hole opening; fig.6, el.82, forming a second photoresist layer over said substrate, including said hole opening and patterning said second photoresist to form a second photoresist mask having a trench pattern; fig.9, etching said second insulative layer through said trench pattern in said second photoresist mask to form a trench in said second insulative layer, thus completing the forming of said dual damascene structure in said substrate; fig.10, removing said second photoresist mask; fig.11, removing said low-k protection layer from over said substrate and from the bottom of said hole opening and thereby exposing underlying said passivation layer while leaving said low-k protection layer on the vertical sides of said hole opening; fig.6, el.82, removing said passivation layer from said bottom of said hole opening, thereby exposing underlying said first metal layer; fig.7, el. 82, 86, forming a barrier layer over said substrate, including in said dual damascene structure; fig.13, el.104, depositing a second

metal, such as copper, over said barrier layer in said dual damascene structure; fig.13, el.106, and performing chemical mechanical polishing (CMP) to complete the forming of said dual damascene structure, col.8, ln.62-63. Further, Zhou teaches forming a low-k protection layer comprises SiO₂, SiN, SiC and SiNC, col.6, ln.18-25, wherein said low-k protection layer has a thickness between about 20 to 1000 Å, col.6, ln.46-50, and wherein said barrier layer comprises Ta, Ti, TaN, TiSiN, TaSiN, WN, col.8, ln.56-58.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

6. Claims 11, 23-24, 27, and 29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhou as applied to claims 1, 3-5, 7-10, 12-16, 18-20, 22, 25-26, 28, and 30 above, and further in view of Lin (6,140,220). Zhou appears not to specify the thickness of the barrier film, nor the etch chemistry used to etch the first and second insulators, the etch stop layer, and the protective layer. Lin teaches forming a barrier layer comprising Ta or TaN, having a thickness of 100-2000 Angstroms, col.4, ln.18-23. It would have been obvious to one of ordinary skill in the art at the time of the invention to combine Lin with Zhou to use a barrier layer of the same material with a thickness used by Lin to prevent via poisoning, thereby reducing contamination of the interconnect structure.

7. Further, Lin teaches using etchant gases containing CHF_3 and CF_4 mixed with oxygen. It would have been obvious to one of ordinary skill in the art at the time of the invention to employ the well known teachings of using fluorocarbon and oxygen etch chemistry, as exemplified by Lin, to etch the materials of the first and second insulator, the etch stop, and the protective layer, in order to etch these materials quickly and under control, while also producing volatile exhaust gases that helps keep the wafer and chamber cleaner from contaminants. In addition, it is well known in the art to employ inert carrier gasses, such as Ar and Nitrogen. It would have been obvious to one of ordinary skill in the art at the time of the invention to use Ar and nitrogen to control the etchant concentration in the chamber, thereby better controlling the etch rate of the material being etched, thereby reducing the chances of over-etching the material.

8. Claims 2, 6, 17, and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhou as applied to claims 1, 3-5, 7-10, 12-16, 18-20, 22, 25-26, 28, and 30 above, and further in view of Eissa et al. (US2002/0127876). Zhou appears not to specify the k value of the low-k dielectric used in the first and/or the second dielectric. Eissa teaches the use of a low-k dielectric in a copper dual damascene interconnect structure having a k value between 2.0 and 3.0, page 1, par. [0010]. It would have been obvious to one of ordinary skill in the art at the time of the invention to select a low-k dielectric having a k-value between 2.0 and 3.0 in an interconnect structure having copper, in order to reduce the parasitic capacitance of the interconnect thereby reducing the RC constant and increasing the speed and performance of the devices.

Response to Arguments

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9. Applicant's arguments filed 2/10/03 have been fully considered but they are not persuasive. Applicant asserts that claims 8 and 25 have been amended to overcome their rejection under 35 USC 112, par.2. Such an assertion is incorrect. Claims 8 and 25 have not been amended and the rejection stands.

10. On p.9 of applicant's response, applicant asserts that Zhou fails to teach the formation of SiO_2 in forming a protection layer. Applicant's attention is directed to col.8, ln.5-20, which further elaborates on the reaction chemistry. Note that the sulfur containing gases consist of SO_2 and SO_3 and further include oxygen gas. During the sulfating and sulfonating reactions the oxygen will react with the silicon and thus form SiO_2 at claimed. The sulfur-containing layer also contains silicon dioxide.

11. Applicant argues that Zhou performs applicant's two steps simultaneously, but applicant's claims fail to require separate steps. A simultaneous step is within the scope of the claims.

12. Applicant also argues that Zhou teaches two protective coatings, while applicant teaches just one. The claims use the term "comprising", which broadens the scope of the claims to include extra steps and layers.

13. Applicant asserts that Lin teaches a barrier layer 100 to 2000 angstroms, while the claimed invention only claims 30-500 angstroms. The ranges overlap and therefore the claimed invention infringes on Lin.

14. Applicant attacks the Lin reference asserting that Lin does not teach the etching of low-K dielectrics, but rather silicon oxide and nitride. Applicant further asserts that the claimed recipe "would be of no use to Lin". Applicant's attention is directed to applicant's claim 19 and 24,

which teach applicant's claimed recipe is used to etch an etch stop layer, which is claimed to consist of silicon nitride. In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208

USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986).

15. Finally, applicant asserts that Eissa teaches the use of commercial low-k dielectric products, which are well known in the art, thus not teaching anything new. The cited art is used in the rejection to merely assert that the use of a low-k dielectric with a value between 2 and 3, is known and would be obvious. Applicant's arguments seem to be confirming the examiner's assertion.

CONCLUSION

16. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.

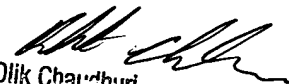
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17. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Neal Berezny whose telephone number is (703) 305-1481. The examiner can normally be reached on M-F 9:00 - 5:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on (703) 308-4918. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 308-7724 for regular communications and (703) 308-7724 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

NB
April 25, 2003


Olik Chaudhuri
Supervisory Patent Examiner
Technology Center 2800